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Attorney Docket No.: PA000307
Date: 5/22/00
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Transmitted herewith for filing is the patent application of:
Inventor(s): DAISUKE TERASAWA ET AL.
For: METHOD AND APPARATUS IN A CDMA COMMUNICATION SYSTEM

Enclosed are:
1. ☒ Patent application (11) total pages.
2. ☒ Drawings: ☐ Formal ( ) sheet(s) or ☒ Informal (2) sheet(s).
3. ☒ Declaration/Power of Attorney: ☐ Signed ☒ Unsigned
4. ☐ An Assignment ( ) pages and Recordation Form Cover Sheet.
5. ☐ A Preliminary Amendment ( ) pages.
6. ☒ Information Disclosure Statement (IDS):
   a. ☒ PTO-1449
   b. ☒ Copies of IDS Citations (number of citations: 5)
7. ☐ Other:

CLAIMS:	(a) Filed	(b) Extra Claims	Large Entity Fee	Fee Paid
Total*	11 - 20	0	x $18 =	$0
Independent**	4 - 3	1	x $78 =	$78
Multiple Dependent Claim(s): ☒ No ☐ Yes			$260	$0
APPLICATION FILING FEE			$690	$690
			TOTAL FEE	$768

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Date: 5/22/00

Signature: S. Hossain Beladi

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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of	)	
DAISUKE TERASAWA ET AL.	)	**For: METHOD AND APPARATUS IN A CDMA COMMUNICATION SYSTEM**
Serial No. UNKNOWN	)	
Filed: HEREWITH	)	**Group Art Unit: UNKNOWN**

CERTIFICATE OF MAILING UNDER 37 CFR § 1.10

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METHOD AND APPARATUS IN A CDMA COMMUNICATION SYSTEM

BACKGROUND OF THE INVENTION

I. Field of the Invention

The present invention relates to communication systems. More particularly, the present invention relates to a novel and improved method and apparatus for soft handoff operations in a communication system operating according to Wideband Code Division Multiple Access (WCDMA) principles.

II. Description of the Related Art

The 3rd Generation Partnership Project (3GPP) recently issued a version of its technical specifications commonly referred to as the WCDMA standard. The publication is well known in the art, and describes the operational standard in a WCDMA system. The standard is still evolving at the time of this application for a patent. A copy of the standard may be obtained by contacting 3GPP, 650 Route des Lucoles – Sophia Antipolis, Valbonne – France, or by accessing the World Wide Web at the internet address www.3gpp.org. The latest version of the standard at the time of this application for a patent, and all previously revised publications of the same, are incorporated by reference herein.

Soft handoff operation is well known. A patent issued to Blakeney, II et al, with U.S. Patent number 5,640,414, and a patent issued to Gilhousen et al, with U.S. Patent number 5,101,501, both assigned to the assignee of the present application for a patent, both incorporated by reference herein, provide methods and systems for providing soft handoff in communications in a CDMA communication system. Generally, a mobile station in soft handoff operation receives and combines multiple signals transmitted from different cells in order to improve the overall decoding and demodulation of the information. The signals transmitted from the cells involved in the soft handoff operation carry the same information. The mobile station after decoding and demodulating the signals combines the data metrics in a soft summing operation to add the data energy. As a result, the information data is received with less error.

In CDMA systems, including WCDMA systems, each cell may have a unique pseudo random noise (PN) sequence. Downlink signals transmitted from each cell are multiplied with the PN sequence as a part of the signal spreading function. The downlink signal received by a mobile station is subjected to a de-spreading operation in accordance with the PN sequence used by the transmitter. The result of the de-spreading operations at the data symbol level is combined with the result of de-spreading operation of other signals transmitted by other cells involved in the soft handoff operation. Signals originating from the same cell but arriving at the mobile with different delays due to multipath can be combined in the same manner. A commonly known Rake receiver may be used for the combining operation.

When performing the soft-combining operation, it is important that the mobile combines the matching symbols received from the cells involved in soft handoff. For example, the first symbol of a particular frame from a first cell needs to be combined with the first symbol of the matching frame from a second cell, and so on. The mobile station needs to know the frame timing of the data signals from each cell. Due to factors including the possibility of cell timing being asynchronous with each other, the possible timing offset between the PN spreading code frame timing and the data frame timing, and the uncertainties in the propagation delay, the mobile cannot necessarily rely on the arrival timing of the symbols from each cell to determine which symbols should be combined.

Therefore, there is a need for a method and apparatus for ensuring that a mobile station is aware of the data frame time offset of each downlink signal transmitted by each cell involved in a soft handoff operation at the mobile station.

SUMMARY OF THE INVENTION

The present invention is directed to a novel and improved method and apparatus, in a communication system, for informing a mobile station of a downlink data frame time offset by determining the downlink data frame time offset, and transmitting the downlink data frame time offset from a cell to the mobile station. The method and the accompanying apparatus further advantageously include receiving time offset information measured by the mobile station. Determining the downlink data frame time offset is based on the time offset measured by the mobile station. The mobile can determine the timing of the frame boundaries based on the offset information in the message. The timing offset measurement report sent by the mobile and received by the

network is used by a new cell to come up with the frame offset. Once it comes up with the offset, it signals the chosen offset to the mobile. The method and the accompanying apparatus further advantageously include receiving the time offset via a measurement report message. The time offset is measured by the mobile station. The measurement report message is transmitted by the mobile station to at least a base station controller controlling the cell. Once the mobile station receives an Active Set Update message, the data frame time offset information is provided to a timing block. Upon knowing data frame time offsets associated with each downlink signal, the timing block may determine data frame boundaries of each downlink signal. The timing block may then adjust the PN sequence timing corresponding to the downlink signal associated with the data frame time offset such that corresponding data symbols in each data frame are correctly soft combined in a combiner. The result of the soft combining operation is subjected advantageously to a demodulator/decoder for retrieving the information.

BRIEF DESCRIPTION OF THE DRAWINGS

The features, objects, and advantages of the present invention will become more apparent from the detailed description set forth below when taken in conjunction with the drawings in which like reference characters identify correspondingly throughout and wherein:

FIG. 1 is a block diagram of downlink signal timing with respect to each other and an uplink signal communicated between a mobile station and two cells in a soft handoff condition in a communication system; and

FIG. 2 is a block diagram of a portion of a receiver in a mobile station for determining time boundaries of data symbols based on data frame time offsets communicated to the mobile station via an Active Set Update message in accordance with various embodiments of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A method and apparatus has been described in a patent application titled: "Method and Apparatus for Fast WCDMA Acquisition", with serial number: 09/345,283, commonly assigned to the assignee of the present application, and incorporated by reference herein. The 09/345,283 application provides a description for a method and apparatus for synchronization of a mobile station with a cell. Based on the synchronization data, the mobile

station is able to determine a data frame time offset referenced to the mobile station uplink data frame timing. The uplink signal according to the standard is transmitted within a fixed time offset after reception of a downlink signal from a cell. The uplink signal time offset may be fixed to 1024 chips. The mobile station, after determining the observed time difference, transmits the information to the cell via a message commonly known as an SFN-SFN message. The 3G TS 25.331 v3.2.0 (2000-03) document, section 10.3.7.90, provides the description and the requirements for the observed time difference message. The observed time difference information is included in a cell measurement results message 10.3.7.3. The mobile station may periodically report to the cell. The mobile station measures and reports the time difference in a unit of a chip time.

The cell in connection with its base station controller sets data frame time offset for a downlink physical channel intended for the mobile station that reported the SFN number on a measurement report message. The 3G TS 25.221 v3.2.0 (2000-03) document, section 7 and its subsections, provides the description for the timing difference between different physical channels. For example, the primary common control physical channel is used as a timing difference for all physical channels, directly for the downlink and indirectly for the uplink. The dedicated physical channels intended for communication of data and voice information are set in a data frame time offset from common control and pilot physical channels. The data frame time offset is set in a multiple of 256 chips from the common control and pilot physical channels.

The mobile station transmits a report message based on the measurement of the signals, such as the sync and the common pilot signals, for each cell within a range. Each report message contains the time delay difference measurement between the uplink timing and the downlink PN sequence frame timing from each cell (i.e. common and pilot channel frame timing) and an SFN number. The propagation distance from each base station to the mobile station may be different. The observed time difference measured by the mobile station for each cell may be different. The downlink data frame time offset is set by each cell based on its corresponding measurement report. Each cell may be operating on its own timing synchronously or asynchronously.

Referring to FIG. 1, in an exemplary situation, a mobile station 101 in a soft handoff situation with cells 102 and 103 receives two downlink signals 111 and 112. A mobile station may be in soft handoff with more than two cells; however, for simplicity of explanation, only a two-way handoff situation is

described. Mobile station 101 transmits uplink signal 113 to be received by cells 102 and 103. Each cell uses the time offset value reported in the measurement report message to set the data frame time offset such that the downlink signal received by the mobile station is approximately 1024 chips away in time from the uplink signal transmitted from the mobile station. For illustrative purposes, for example, uplink signal 113 is transmitted at time 120. Cell 102 communicates to mobile station 101 via downlink 111. If the common control channel time reference of cell 102 is at time 121, cell 102 sets a data frame time offset 122 from time 121 such that after taking into account the propagation delay 123, downlink signal 111 arrives approximately 1024 chips time away from uplink transmit time 120.

Mobile station 101 transmits a measurement report message to the network including a base station controller 190 which informs cell 103 the timing information necessary for determining a time frame offset 124 associated with downlink 112. Cell 103 sets data frame time offset 124 such that after including a propagation delay 125 associated with propagation delay of downlink signal 112, downlink signal 112 arrives at mobile station 101 approximately 1024 chips time away from uplink transmit time 120. The downlink signals 111 and 112, thus, arrive within approximately 1024 chips time of the uplink signal 113 at mobile station 101. When mobile station 101 is in soft handoff with base stations 102 and 103 via downlink signals 111 and 112, respectively, the soft combining operation may be performed.

In one embodiment of the invention, the data frame time offset 122 and 124 are in increments of 256 chips time. The beginning of the PN sequence is set to coincide at the beginning of the cell common control and pilot channel time frame. Each downlink physical channel is spread with a PN sequence. As such, each downlink signal is at least 256 chips in time offset from the other. Downlink signals to different mobiles can have the same timing offset.

In one embodiment of the invention, when the mobile station 101 is performing soft combining at the data symbol level, the data symbols extracted from each downlink signal may be identified in terms of location in the data frame for an effective soft combining operation with another data symbol in the same location of another data frame. Each data symbol may be between 4 and 512 chips in duration. The data frame time offset is in increments of 256 chips. Data symbols transmitted via the downlink signals then need to be identified at the mobile station for the soft combing operation. Data frame time offset 122 is set by cell 102 and data frame time offset 124 is set by cell 103, depending on the measurements reported by the mobile station. The data symbols S1X received

via downlink signal 111 need to be combined with data symbols S2X received via downlink signal 111. if mobile station 101 is not aware of the data symbol boundaries, data symbols of different downlink signals may not correspondingly be combined. Since the cells attempt to adjust the transmit timing of the data channel so that signals from different cells arrive at the mobile station at roughly the same time, one thing the mobile may do is combine symbols that are "closest" together in time. However, the possibility of propagation time relationships changing between the time of measurement report and the start of the soft combining operation leaves ambiguities for the mobile station for soft combining operation.

According to various embodiments of the invention, in a communication system 100, a method and accompanying apparatus provide for informing mobile station 101 of a downlink data frame time offset by determining the downlink data frame time offset, and transmitting the downlink data frame time offset via an Active Set Update message transmitted from a cell to mobile station 101. The method and the accompanying apparatus further include receiving time offset information measured by mobile station 101. Determining the downlink data frame time offset is then based on the time offset measured by mobile station 101. The method and the accompanying apparatus further include receiving the time offset via a measurement report message. The time offset is measured by mobile station 101. The measurement report message is transmitted by mobile station 101 to at least base station controller 190.

In one embodiment of the invention, mobile station 101 may adjust its internal timing after identifying the boundaries of data symbols for the combining operation. An effective combining operation is possible since according to an embodiment of the invention, mobile station 101 is aware of the data frame time offset used by the cells. Mobile station 101 is able to determine data symbol boundaries since the downlink signal is spread by a PN sequence whose beginning coincides with the beginning of the common control channel and the pilot channel. Mobile station 101 while in communication with a cell knows the timing boundary of the common control channel and the pilot channel, as deduced from timing associated with the beginning of the PN sequence through an ongoing synchronization process. The mobile station 101 measures the PN sequence timing. Knowing the relationship between the PN sequence timing and the control/pilot channel frame timing allows mobile station 101 to deduce the frame timing. Mobile station 101 de-spreads the downlink signal by removing the PN sequence from the signal. The boundary of the first data symbol is in time offset in increments of the data frame time

offset from the beginning of the PN sequence. Therefore, once the mobile station knows the data frame time offset, it can determine the location of the data frame boundary with respect to the PN sequence timing. Since data symbols are fixed in duration, boundaries of subsequent data symbols after the first data symbol can easily be determined. The data symbol combining operation takes place after the despreading operation. The mobile station can adjust the data symbol boundaries of a Rake receiver finger to coincide to the data symbol boundaries outputting from other fingers assigned to other downlink signals.

The 3G TS 25.331 v3.2.0 (2000-03) document, section 8.3.4, provides a procedure for generating Active Set Update message in a soft handover operation, otherwise known as a soft handoff operation. The purpose of the Active Set Update is to update the active set of the connections between the mobile station and various cells involved in the soft handoff operation. The base station controller (BSC) 190 initiates the procedure to modify the downlink connections. For all the signaling activities including– ACTIVE SET UPDATE, MEASUREMENT REPORT, etc , the mobile station is in communication with the BSC 190 (or radio network controller (RNC) in WCDMA terminology). Each cell includes a transceiver that does some physical layer processing (such as coding/decoding, interleaving/deinterleaving, and spreading/despreading.) The 3G TS 25.331 v3.2.0 (2000-03) document, section 8.5.7, provides the description for generic actions for receipt of the information. A new Section 8.5.7.6.13 may be added that may describe according to various embodiments of the invention what mobile station 101 is expected to do when it receives data frame time offset. Pursuant to the section 10.3.6.15, Downlink DPCH information for radio link may be modified to include the data frame time offset associated with the downlink. The data frame time offset may be communicated in increments of a chip time or 256 chip times.

Referring to FIG. 2, a simplified block diagram of a receiver in a mobile station is shown for soft combining operation according to various embodiments of the invention. Downlink signals 204 and 205, after proper down conversion and signal processing (not shown), are input to de-spreaders 202 and 203. Each downlink signal may be associated with a cell. Once an Active Set Update message is received, the data frame time offset information is provided to a timing block 201. Upon knowing the data frame time offset associated with each downlink signal, timing block 201 may determine the data frame boundaries of each downlink signal. Timing block 201 may then adjust the PN sequence timing corresponding to the downlink signal associated with

the data frame time offset such that corresponding data symbols in each data frame are correctly soft combined in a combiner 210. The result of the soft combined operation is provided to the demodulator/decoder 220 for retrieving the information.

Accordingly, a soft combining operation at the data symbol level is performed with high efficiency and accurate results.

The previous description of the preferred embodiments is provided to enable any person skilled in the art to make or use the present invention. The various modifications to these embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments without the use of the inventive faculty. Thus, the present invention is not intended to be limited to the embodiments shown herein but is to be accorded the widest scope consistent with the principles and novel features disclosed herein.

WE CLAIM:

Claims

1. In a communication system, a method for informing a mobile station of a downlink data frame time offset comprising:

determining said downlink data frame time offset;

transmitting said downlink data frame time offset from a cell to said mobile station.

2. The method as recited in claim 1 wherein said downlink data frame offset is included in an Active Set Update message and said communication system is operating according to WCDMA standard.

3. The method as recited in claim 1 further comprising:

receiving a time offset measured by said mobile station,

wherein said determining said downlink data frame time offset is based on said time offset measured by said mobile station.

4. The method as recited in claim 3 wherein said receiving said time offset is performed via a measurement report message transmitted by said mobile station.

5. The method as recited in claim 3 further comprising:

adjusting timing of a time offset adjuster in said mobile station for adjusting data symbol timing according to said downlink data frame time offset and for identifying corresponding data symbols for a soft combining operation.

6. The method as recited in claim 5 further comprising soft combining said corresponding data symbols.

7. An apparatus in a communication system comprising:

a receiver configured to receive a downlink data frame time offset transmitted from a cell to a mobile station;

a time offset block for adjusting data symbol timing according to said downlink data frame time offset.

8. The apparatus of claim 7 wherein said receiver and said time offset block are included in said mobile station.

9. An apparatus in a communication system comprising:

means for determining a downlink data frame time offset;

a transmitter for transmitting said downlink data frame time offset via an Active Set Update message from a cell to a mobile station, wherein said message is for informing said mobile station of said downlink data frame time offset.

10. The apparatus of claim 9 wherein said means for determining and said transmitter are included in a communication base station including said cell and a base station controller.

11. An apparatus in a communication system comprising:

means for determining a downlink data frame time offset;

a transmitter for transmitting said downlink data frame time offset via an Active Set Update message from a cell to a mobile station, wherein said message is for informing said mobile station of said downlink data frame time offset;

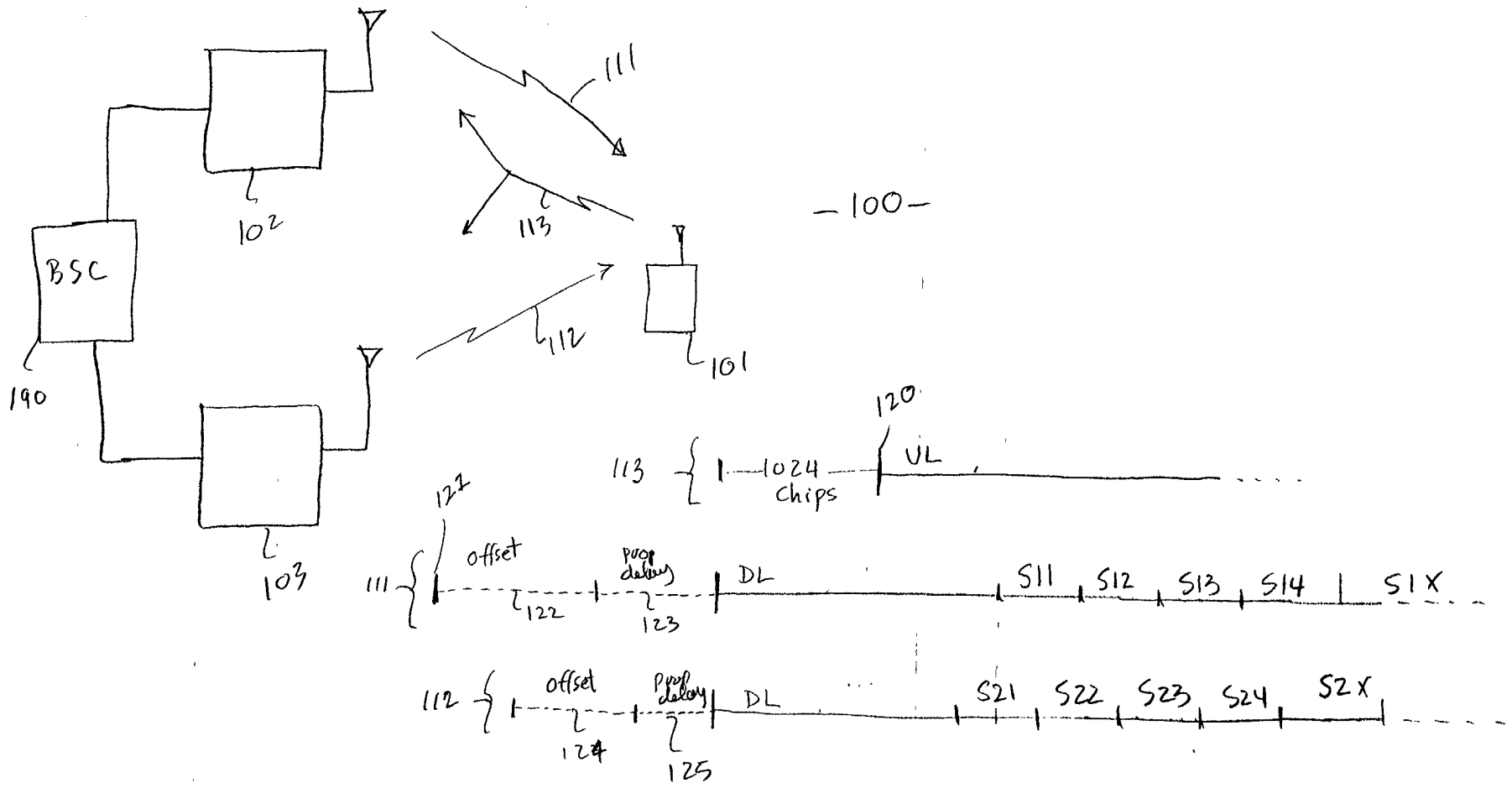
a receiver for receiving said downlink data frame time offset via said Active Set Update message;

a time offset adjuster in said mobile station for adjusting data symbol timing according to said downlink data frame time offset.

METHOD AND APPARATUS IN A CDMA COMMUNICATION SYSTEM

ABSTRACT OF THE DISCLOSURE

A novel and improved method and apparatus, in a WCDMA communication system (100), for informing a mobile station (101) of a downlink data frame time offset by determining the downlink data frame time offset, and transmitting the downlink data frame time offset via an Active Set Update message transmitted from a cell (102 or 103) to mobile station (101). Once an Active Set Update message is received, the data frame time offset information is provided to a timing block (201) which may determine data frame boundary of each downlink signal. Timing block (201) may then adjust the PN sequence timing corresponding to the downlink signal associated with the data frame time offset such that corresponding data symbols in each data frame are correctly soft combined in a combiner (210).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113
BSC
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101
190
103
120
113
1024 chips
UL
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offset
prop delay
DL
S11
S12
S13
S14
S1X
111
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123
offset
prop delay
DL
S21
S22
S23
S24
S2X
112
124
125

FIG. 1

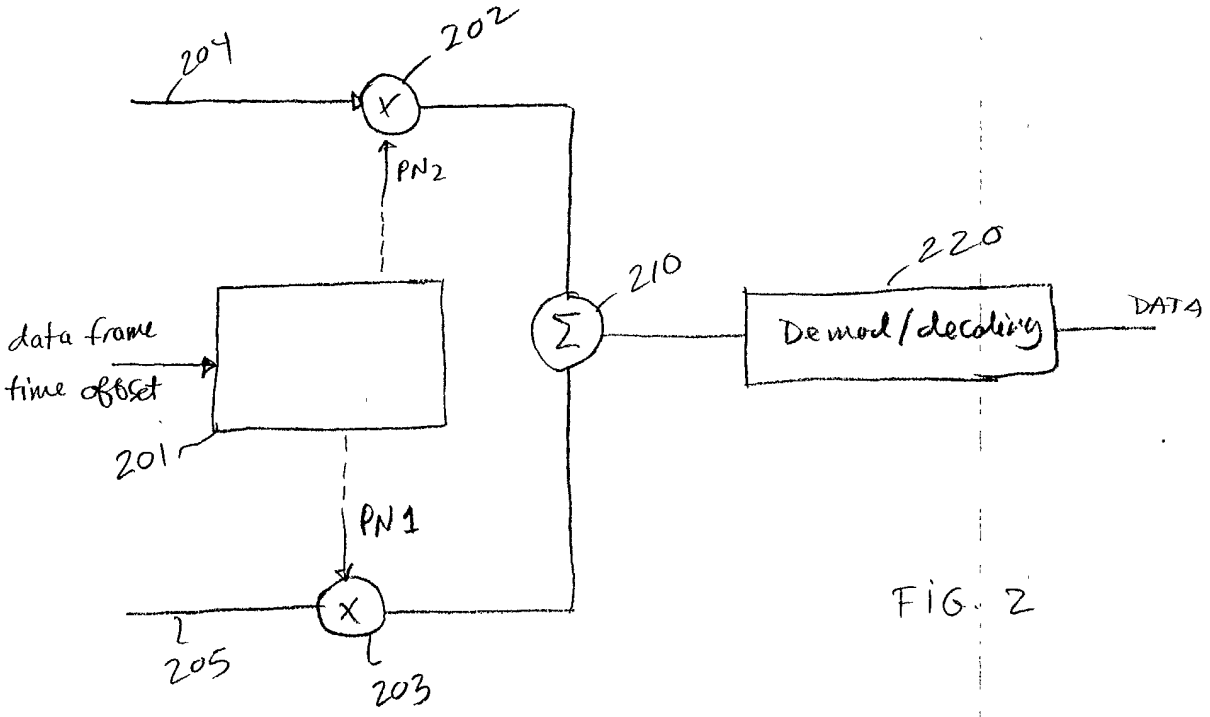
204
202
X
PN2
data frame
time offset
201
210
Σ
220
Demod/decoding
DATA
PN1
X
205
203

FIG. 2

COMBINED DECLARATION/POWER OF ATTORNEY

ATTORNEY DOCKET NO.: PA000307

AS BELOW NAMED INVENTOR, I HEREBY DECLARE THAT: This Declaration is of the following type:

[X] Original [ ] Supplemental [ ] Continuation-In-Part [ ] Divisional
[ ] Continuation [ ] National Stage of PCT

My residence, post office address and citizenship are as stated below next to my name: I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: **METHOD AND APPARATUS IN A CDMA COMMUNICATION SYSTEM**, the specification of which:

[X] is attached hereto.
[ ] was filed on _____ as Serial No. _____ .
[ ] was described and claimed in PCT International Application No. _____ filed on _____
and as amended under PCT Article 19 on _____ .

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to the examination of this application in accordance with 37CFR § 1.56(a).

I hereby claim foreign priority benefits under 35 USC § 119 of any foreign applications for a patent or inventor's certificate or of any PCT International applications designating at least one country other than the United States listed below and have also identified below any foreign applications for a patent or inventor's certificate or any PCT International applications designating at least one country other than the United States filed by me on the same subject matter having a filing date before that of the applications of which priority is claimed.

			Priority Claimed	
(Country)	(Application No.)	(Day/Month/Year/Filed)	(Yes)	(No)

I hereby claim the benefit under 35 USC § 120 of the United States application(s) listed below, and insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of 35 USC § 112, I acknowledge the duty to disclose material information as defined in 37 CFR 1.56(a) which occurred between the filing date of the prior application and the national or PCT International filing date of this application:

(Serial No.)	(Filing Date)	(Status)

I hereby appoint the following attorneys and/or agents to prosecute this application and to transact all business in the U.S. Patent and Trademark Office connected therewith: Russell B. Miller, Reg. No. 31,122, Gregory D. Ogrod, Reg. No. 30,880, Sean English, Reg. 37,319, Roger W. Martin Reg. No. 39, 291, Thomas R. Rouse Reg. No. 40,793, Kevin J. Clark, Reg. No. 42,421, Thomas Streeter Reg. No. 30,007, Kent D. Baker Reg. No. 38,882, Thomas M. Thibault Reg. No. 42,181, Charles D. Brown Reg. No. 28,285, Kyong H. Macek Reg. No 42, 977, Byron Yafuso Reg. No. 45,244, Pavel Kalousek Reg. No.44,178, Christopher O. Edwards Reg. No. 36,127, Raymond Hom Reg. No. 44,773 and Bruce W. Greenhaus Reg. No. 37,339, Philip R. Wadsworth, Reg. No. 29,219; Sayed Hossain Beladi, Reg. No. 42,311, Michael D. Hartogs, Reg. No. 36,547; Sandip Minhas, Reg. No. 44,945. Please direct all telephone calls to Philip R. Wadsworth at (858) 651-4404 and address all correspondence to: Jean Lupien, QUALCOMM Incorporated, 5775 Morehouse Drive, San Diego, California 92121-1714.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 USC § and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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